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surface of the cement. This is achieved by adding to the concrete mixture surface-active admixtures of organic origin containing salts of lignosulfonic acids. These substances, which hinder flocculation and dissociation (dispersion) of the cement particles, are at the same time plasticizing admixtures which increase the mobility and workability of the concrete mixture.

Observations of cement suspension containing a very small quantity of a calcium salt of lignosulfonic acid under the microscope shows its dispersing action. By preparing the cement suspension with and without an additive of concentrates containing the calcium salt of lignosulfonic acid, one can see that in the mixture with the additive of concentrate, a large number of particles of cement along the side of the vessel is observed, while in the mixture without the additive, there is transparent water above a shallow precipitate. It is obvious that the addition of the salt of lignosulfonic acid hindered the formation of the flakes of cement particles and by this very fact, decreased precipitation of cement particles. Nevertheless, in this case, particles of cement are packed together after precipitation more tightly than in cement suspensions without additives.

The dispersion of small particles in aqueous suspensions is usually regarded as a consequence of the mutual repulsion of electrically charged particles. This phenomenon also takes place in the case of a cement-water suspension, dispersed with the help of salts of lignosulfonic acid, as was established by observing under the microscope the electrophoresis migration of cement particles suspended in water. The latter, when suspended in distilled water do not manifest a tendency to migration in the direction of the electrode. The particles agglomerate and settle so rapidly that it is difficult to locate one of them for observations.

On the other hand, when salts of lignosulfonic acid are introduced into a suspension, the cement particles, under the influence of an applied potential difference, migrate noticeably toward the anode and hydroxides of the metal are formed on the cathode. Hence, it may be concluded that the cement particles, which absorb anions of lignosulfonic acid acquire a negative charge which brings about peptization of the cement particles in the suspension and results in greater stability. The coagulation of cement particles, i.e., the formation of flake clots, acts against mutual repulsion of charged particles of the same sign.

As was pointed out above, the negative charge of the cement particles can be ascribed to their adsorption of anions of a salt of lignosulfonic acid. The existence of such ions was established by an electrophoresis experiment. When an aqueous solution of concentrate containing the calcium salt of lignosulfonic acid is introduced into an electrophoresis instrument, and a potential applied, the brown lignosulfonic complex moves in the direction of the anode and forms a sharp boundary with a colorless solution surrounding the cathode. In the cathode solution a precipitate of calcium hydroxide $\text{Ca}(\text{OH})_2$ appears. It is obvious that the calcium salt of lignosulfonic acid is a colloidal electrolyte which ionizes in solution and forms cations of the metal and lignosulfonate anions.

The table below gives data which characterize the increase of specific surface of the cement when calcium lignosulfonate is added to the cement suspension. The determination of the specific surface of the cement grains of the suspension was done by means of a turbidimeter. Water instead of kerosene was used as the suspending medium. The cement was first mixed with water, and with a water solution of calcium lignosulfonate for 2 minutes.

The observance of the rigid conditions under which the experiment was carried out ruled out relative errors which might have reflected on the experimental results obtained due to the influence of hydration.

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<u>Characteristics of Cement Based on Fineness of Grind</u>	<u>Absorbed Ligno- sulfonate in % of Cement Weight</u>	<u>Mean Specific Surface (sq cm/g)</u>	<u>Apparent % Increase of Specific Surface of Cement Grains of Dispersed Cement Suspension</u>
Type I. Specific sur- face of cement in kero- sene 1,690 sq cm/g	0.0	1,150	0
	0.2	1,505	31
	0.3	1,570	37
	0.4	1,685	47
	0.5	1,705	48
Type III. Specific sur- face of cement in kero- sene 2,590 sq cm/g	0.0	1,820	0
	0.2	2,300	26
	0.3	2,400	32
	0.4	2,575	41
	0.5	2,630	44

The results of the experiments indicate the considerable increase of dispersion of cement particles when calcium salts of lignosulfonic acid are added. The dispersion of cement in a concrete mixture should have the following results:

1. Better results in placing the concrete due to decreased water content.
2. Decrease of lamination and increase in water-retaining properties.

Therefore, the following results of great significance should be expected in the solidified concrete: increased strength, decreased water permeability, increased frost and water resistance, and as a result, a longer life for the structure.

The first person in the USSR to work on the preparation of a dispersion reagent and "plastiment" /plasticizer/ was Professor B. M. Zhuravlev, Doctor of Technical Sciences, Leningrad Chemico-Technological Institute.

Work now being done in the Laboratory of Hydrotechnical Construction Materials of VNIIG (All-Union Scientific-Research Institute of Hydraulics) is directed toward investigating the effectiveness of using the Soviet dispersing and plasticizing additives containing salts of lignosulfonic acid in the manufacture of hydrotechnical concrete and in particular, to improve such important properties of this concrete as frost resistance, water tightness, and water resistance. The basic materials containing the additives are the by-products obtained in the delignification of wood.

In view of the fact that additives of lignosulfonic acid salts contain, in addition to the basic, very desirable substance, some reducing substances, which may have a harmful effect on the properties of cement solutions and concretes, several specimens from refined additives were tested.

The data obtained from the study of seven different additives showed that when Soviet materials were used, the dispersing and plasticizing action is reflected in the fact that to obtain normal consistency of the cement paste, considerably less water is required for dissolving. The introduction of these

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additives helps to lengthen the setting time of the cement paste, especially the end of setting, which takes almost twice as long when 0.2-0.25% of dry concentrate substance is added.

The introduction of dispersing additives considerably increases the mobility of the cement solution, keeping the plastic consistency of the cement solution constant. The additives used in the USSR reduce the value of the water-cement factor from 0.58 to 0.50, i.e., to decrease the water requirement by about 14%. This factor is especially important for hydrotechnical concrete since, as is well known, the quality of water-tight and frost-resistant concrete depends on the cement or stone in the concrete, which in turn, depends to a large extent on the water-cement ratio. In cases where slack-Portland cement was used, considerable increase in strength was observed for the cement solution.

Experiments with plastic concrete made of Portland cement show that the introduction of Soviet dispersing additives also helps to lower the water-cement ratio without changing the consistency of the concrete. The compressive strength of the concrete is thereby increased. There is every reason to suppose that the favorable effect of these additives will produce similar results with respect to water tightness, frost resistance, and corrosion resistance of hydrotechnical concrete. This research is now being carried out in the Laboratory of Hydrotechnical Construction Materials of VNIIG.

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